September 27, 2016

Via Electronic Filing

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: ***Starry, Inc., Comments on Further Notice of Proposed Rulemaking****; Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al., GN Docket No. 14-177, IB Docket Nos. 15-256 and 97-95; and WT Docket No. 10-112*

On July 14, 2016, the Federal Communications Commission (FCC) adopted and released its Report and Order and Further Notice of Proposed Rulemaking (FNPRM) for the above referenced proceedings, also referred to as the *Spectrum Frontiers* proceeding. Below are comments from Starry, Inc., in response to the questions raised in the FNPRM.

Background

Starry, Inc., is a Boston- and New York-based technology company that is re-imagining last-mile broadband access by utilizing millimeter waves as an alternative to fixed wireline broadband. Starry is the first to develop and deploy active phased array technology for consumer internet communications, capable of achieving speeds of up to one gigabit of internet service. Our experience working in these bands and our beta deployment in Boston proves the great potential of this spectrum to accelerate next generation wireless technology. The availability of spectrum is one of the biggest drivers of modern wireless technology and arguably, one of our country's most valuable natural resources. Starry applauds the Commission's efforts in making available more high-band spectrum for both exclusive-licensing and shared use.

In order to achieve the Commission's goals of promoting innovation and competition in the broadband market, we believe the Commission should adopt in its FNPRM, pro-competitive rules that enable new entrants to meaningfully participate in either exclusive licensing or shared use of high band spectrum.

The adoption of a true, dynamic sharing mechanism for the lower 37 GHz band segment is critical. Starry also proposes that the Commission leverage the same dynamic sharing for the upper bands until such time as licensees build out their networks. Dynamic sharing will enable effective use of this spectrum, encourage competition and ensure that opportunities to invest and innovate in high frequency bands are available to new entrants. Additionally, the Commission must enact rules that allow for flexibility on what technologies, access mechanisms and wave forms (modulations) are deployed in these shared bands. Flexibility will ensure that the pace of innovation and deployment is not artificially stymied and that equipment deployed in shared bands can easily migrate to licensed bands as the market evolves.

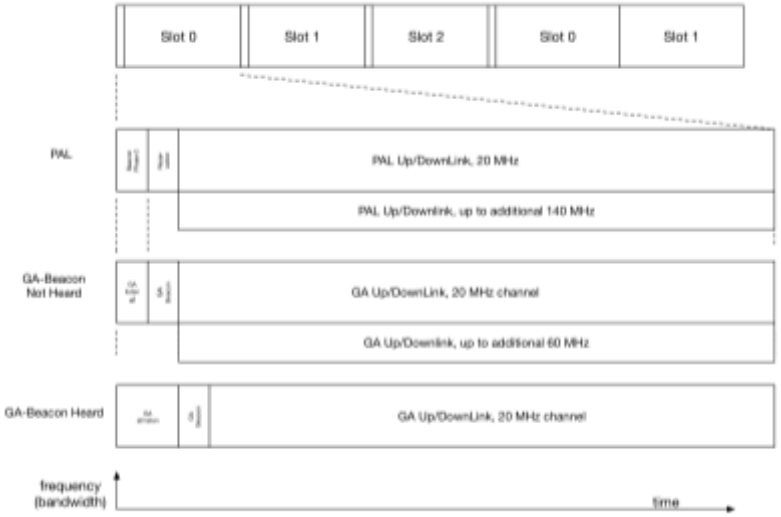
Adopting flexible, pro-competition rules is critical for the United States to remain a leader in developing, deploying and connecting people to next generation wireless technologies. We look forward to working with the Commission and collaborating with federal partners, including the NTIA and others on this critically important matter.

Coordination Mechanism for the Lower Band Segment (37-37.6 GHz)

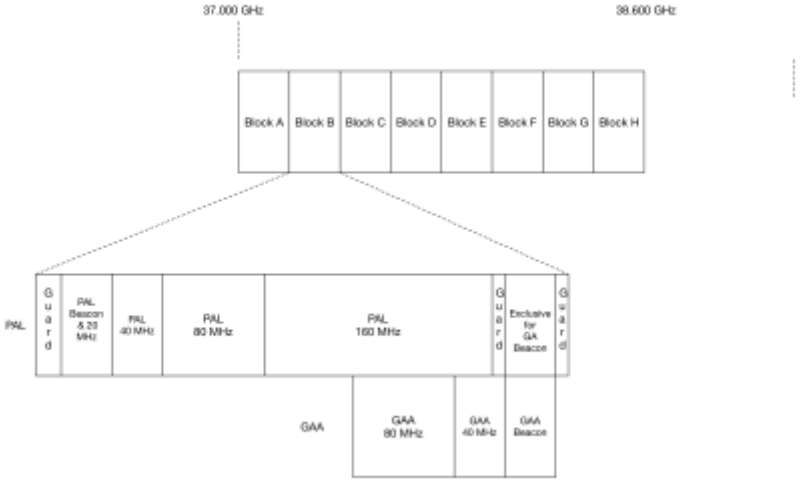
Starry strongly believes that in order for sharing in the lower band segment to be successful that a true dynamic sharing mechanism must be adopted. A dynamic sharing mechanism that leverages simple coordination via automated database registration and utilizes a beacon to validate signal presence in real-time is the most effective and efficient way to manage interference issues and put to use the spectrum in the lower 37 GHz band. This type of system allows for flexibility in the band and simplifies access and coordination for potentials users of the shared band. Additionally, it provides flexibility in working with other federal partners who may participate in the sharing regime.

In order to accomplish this, Starry proposes that all primary access licensees (PALs) use a beacon of not more than 20 MHz transmitted every 100 ms for all primary access licensees (PALs) along with an energy detector-based receiver. Assuming there is equivalent performance at approximately the noise floor of –113.8 dBm, then at some point above this, a reasonable contour exists, perhaps as high as the directivity of a typical broad sector antenna system. So, approximately –94 dBm in a 0 dBi antenna would provide a very reliable contour for the primary holder to be protected.

On the other dynamically shared portions, Starry recommends setting the energy detection at a somewhat higher level, perhaps allowing –64 dBm as a means to allow highest throughput. For example, if a general access licensee (GA) observed a signal of –94 dBm or greater, then it could not utilize the PAL's primary beacon channel. In the event that it was unoccupied and therefore could be utilized, then other GAs may be operating, and the bandwidth would be allocated dynamically, with energy detected up to –74 dBm indicating a clear channel and ability to utilize the channel, much the same as WiFi functions today.



Starry's approach for sharing in the lower band (37-37.6 GHz) would divide it into 200 MHz Blocks, allowing for a PAL for each block or sets of blocks. The beacon system as laid out above would enable timed beacons based on 802.11, which are readily decodable for purposes of identification. PALs would be able to use up to 160 MHz of the 200 MHz block and GAs would be allocated 20 MHz but could be allowed to use up to 80 MHz, depending on availability. This flexible arrangement would also allow in the case of a federal emergency, to enable non-federal co-primary access licensees to move to GA status in the band.



Channelization of the Lower Band Segment

The FNPRM sought comment regarding the establishment of a minimum channel width for the lower band. Starry believes the minimum channel width should be 200 MHz, the same channel size as the exclusively licensed upper band segment. This provides for compatible equipment and usage.

Utilizing the same minimum channel size would create enough operational similarity to enable users to more easily develop equipment that would satisfy the FCC's equipment interoperability requirement for these bands (*Section IV.G.5 (Operability)*). The FCC rules require that a device operating in the 37 or 39 GHz bands be capable of operating at all frequencies within those bands (37 GHz – 40 GHz), therefore it is logical to establish parity in minimum channel size for the lower band sharing segment at 200 megahertz, while permitting sub-channels of 20 megahertz to encourage additional innovation and allow for flexibility in the shared band.

Authorization Expiration / Construction Requirement for the Lower Band Segment

The FNPRM proposes that once registered, non-federal sites must be put into service within seven days of coordination, with those sites reasserting their registration every seven days. If the device fails to check in within the seven-day period, its authorization will lapse.

It remains unclear to Starry what the proposed registration and authorization process is for the lower band segment and what those processes entail. However, as proposed, Starry believes that the seven-day "light up" window, established from the point of authorization to participate in the sharing band, is not appropriate given the reality of build constraints and the myriad of local laws and regulations that must be navigated when siting and building equipment in-market. Local laws governing the siting of new telecommunications equipment and the local zoning and regulatory boards that enforce them, are often unwieldy and unpredictable. Local municipal approval and application processes can take up to 90 days or longer in some jurisdictions. Additionally, uncontrollable factors such as weather or other acts of nature could hamper any build out within a narrow seven-day period, potentially imperiling a user's authorization.

Starry recommends a 120-day construction requirement from the time the user is granted authorization to use a particular portion of the lower band segment. If the user does not "light up" within the 120-day period, then his/her authorization will lapse and expire. Once activated, Starry agrees that reassertion of registration every seven days is appropriate. However, we believe the FCC must establish rules around emergency situations (for example, if a hurricane or other act of nature destroys equipment, there must be an opportunity to rebuild without losing authorization if equipment fails to reassert its registration within the seven-day window) to ensure that shared users are not unfairly penalized by factors out of their control.

Priority Access for Federal Users of the Lower Band Segment

Enabling federal use of the lower band segment is a critical component to the success of the sharing scheme. Starry believes that federal users should be designated as co-primary status with authorized non-federal users. In a true dynamic sharing structure, federal users have flexibility to participate as co-primary licensees or as a general access licensee on transient use. This enables more flexibility for federal users to utilize the lower band when they need it and supports transient use cases without unnecessarily tying up lower band spectrum that remains unused.

Interference Mitigation in the Lower Band Segment

While Starry does not believe that a spectrum access system (SAS) is appropriate as a coordination mechanism, Starry believes the utilization of a frequency coordinator deployed only as a registration mechanism to identify and effectively adjudicate conflicts would be appropriate for assisting in interference mitigation. Any party found to be conflicting with the co-primary licensees would immediately be downgraded to GA status.

Secondary Market Policies for the Lower Band Segment

Starry believes that in order to preserve competition and availability of lower band spectrum, aggregation rules and secondary market rules should also apply to the lower band segment. The accumulation rules established by the Commission should apply to those holding exclusive licenses in the upper band that also seek to participate in the shared lower band, with a combined maximum limit of 1250 megahertz. Additionally, utilizing the same secondary market rules for the lower band segment will streamline processes, create more efficiency and reduce confusion for those users who participate in both exclusive and shared licensing. While

secondary market rules are important, they are more powerful when applied in tandem with aggregation limits to ensure competitiveness, availability of spectrum and discourage warehousing of spectrum.

Sharing Mechanism – "Use or Share" and
"Use or Share" and Federal Sharing in the Licensed Upper Band Segment

Starry believes that a "use or share" regime, deployed in tandem with spectrum aggregation limits, in the UMFUS bands would also be an effective tool to enable maximum use and productivity of spectrum in the mmWave bands and should be deployed simultaneously with the lower band segment sharing.

The utilization of a fully dynamic sharing solution, facilitated by a frequency coordinator/registrar, to make unused geographically licensed spectrum available opportunistically is in the public interest and makes logical sense given the propagation characteristics of the UMFUS bands and the potential for re-use within these bands. Additionally, Starry believes that UMFUS licensees that share unused portions of their licenses and demonstrate a willingness to cooperate in a "use or share" regime should have that participation count towards meeting specific construction requirements. However, it should not be used in lieu of or to replace construction thresholds that must be met to fulfill substantial service requirements at renewal. Starry also believes that the FCC should establish a process by which federal users can coordinate with license holders for future expanded access in the upper band segment.

To facilitate sharing in the UMFUS band, Starry believes that an approach similar to TV White Spaces is appropriate. Starry proposes that shared operation in the upper band be considered similarly as a GAA in the lower band, with the exception that a map with contours of –94 dBm be provided to the frequency coordinator 120 days prior to assertion of the usage of a specific channel. Until that time, any GAA should be allowed to operate as the PAL based solely on a "first-come, first-served" basis, with the same sharing rules governing the lower band. Therefore, the first GAA operating on this band shall become the PAL, until such time as the incumbent license holder asserts its rights 120 days prior to operation.

Performance Requirements – Additional Metrics

Starry believes performance metrics at renewal are critical to ensuring that both exclusively-licensed and shared spectrum is being used appropriately to encourage productive use and avoid warehousing and speculation. The Commission has adopted a requirement that geographic area licensees providing Fixed Service in the 28 GHz, 39 GHz, or 37 GHz bands must construct and operate at least four links in license areas with less than 268,000 population, and at least one link per 67,000 population in license areas with a greater population (*Section IV.F.7 (Performance Requirements)*). We believe that the performance requirements as laid out by the Commission are appropriate and will provide license holders with the operational flexibility required to provide service in these new bands. However, Starry proposes strengthening those performance requirements by including a utilization metric that aggregates all bits of payload data for any devices in any measurement, scaled by the total bandwidth, to ensure not just minimal utilization of the spectrum, but productive, active use of the spectrum.

When it comes to determining metrics to measure the performance of machine-to-machine communications ("Internet of Things") or other services not yet developed, Starry believes that two levels of metrics are suitable for helping evaluate performance: device count per population and the amount of data transmitted. Because of its unique characteristics, millimeter waves are incredibly effective at transmitting enormous amounts of data over a short range.

Starry proposes the same metric as above, aggregating all bits of payload data for any devices in any measurement, scaled by the total bandwidth. Additionally, to encourage the usage of the band as a highly dense transmission medium, to the extent that transmissions are made at a payload density of less than 1 bit/second/Hz-occupied, then these payload bits should not count within the aggregate.

Additionally, we believe any performance measurement should also take into consideration geographic areas that may be highly transient or contain one type of use (commercial versus residential) that may skew usage of both devices and data. And, for entities deploying both fixed line and wireless systems, Starry believes that it is appropriate for the Commission to develop and establish clear guidelines and benchmarks for the amount of buildout that it believes is adequate in a combined buildout.

Mobile Spectrum Holdings Policies with "Use or Share"

The FCC adopted an aggregation limit of 1250 MHz to apply to licensees acquiring spectrum in the 28, 37 and 39 GHz bands through competitive bidding as well as secondary market transactions. Starry agrees that aggregation limits will be effective in promoting competition and availability of spectrum in these

bands. However, Starry believes that this aggregation limit can be more effective if it is structured such that the first 650 MHz of acquired spectrum is not subject to "use or share" rules, while the remaining balance up to 600 MHz of subsequently acquired spectrum is subject to "use or share" rules as established by the Commission. Additionally, Starry believes that an overall aggregation limit of 1250 MHz, whether the spectrum is acquired at auction or via secondary market transaction, would better further the Commission's goals of establishing productive and diverse use of these bands, as the method of accumulation is irrelevant as far as establishing a competitive market is concerned.

The Commission has adopted sharing in these bands because it rightfully recognizes that these are innovation bands, where new technologies are emerging every day and the ability for new entrants to access spectrum is critical. Enacting strong aggregation limits and "use or share" rules will help preserve that spirit of innovation in these mmWave bands. Therefore, we do not support separate aggregation limits for spectrum acquired at auction versus the secondary market, as there is no credible technical reason why they should not be considered together.

This structure would allow licensees to accumulate both exclusively-licensed and shared spectrum in these bands up to 1250 MHz, while simultaneously promoting competition and productive use within these bands by requiring licensees to participate in the "use or share" regime. This structure would achieve three benefits: support the efficacy "use or share" model, encourage productive build out, and prevent consolidation of spectrum in one or two hands. We believe this type of structure successfully balances licensees' needs for exclusive access to spectrum and the Commission's goal of promoting competition. Additionally, we believe that it is appropriate for the FCC to apply similar aggregation limits to future spectrum bands that share similar technical characteristics and/or potential uses. Specifically, mmWave bands up to 59 GHz have similar enough properties and technical characteristics that it would be appropriate to subject them to the same aggregation rules.

With regards to determining bidding eligibility and whether a licensee has exhausted his/her aggregation limit, Starry recommends utilizing a "maximum county to PEA" ratio as proposed by the FCC, which we believe is the most logical approach, rather than using a population weighted average calculation.

Holding Period

The FCC has proposed a three year Holding Period that would preclude certain proposed secondary market transactions for licensees that acquire certain amounts of 28, 37, or 39 GHz spectrum at auction. Starry agrees with the Commission that a Holding Period is important in order to prevent speculation and warehousing, however, Starry recommends establishing a shorter Holding Period of two years.

A shorter Holding Period provides flexibility in the marketplace as technologies continue to evolve. Additionally, the Holding Period, coupled with "use it or share it" rules and aggregation limits will ensure that there is competition and adequate liquidity in the market. Together, these rules will create a competitive spectrum marketplace that remains flexible enough to respond to innovations in technology and consumer demand.

Digital Station Identification

AM/FM/TV broadcasters and land mobile station operators are required to announce their call signs via a digital identification. The FNPRM asks if operators in mmWave bands (28, 37, 39 GHz) should be required to do the same.

Starry believes it is appropriate for the FCC to ask users to provide an observable and decipherable beacon (announcement ID), provided that the announcement ID be chosen by the Operator and information to decode it be disclosed publicly in an open source format, so as to facilitate decoding by the FCC and any other interested parties. With the ready availability of software-defined receivers and the advent of high speed analog to digital converters and receivers that enable easy decoding, the responsibility of the choice of digital identification can fall to operators, which will not pre-determine or restrict the arguably more important choice of transmission technology.

Therefore, Starry does not believe that the Commission should mandate the type of announcement ID or beacon. However, Starry supports the notion that operators should file identification schemes with the Commission's Office of Engineering and Technology to facilitate decoding identifications.

Technical Issues – Antenna Height

The FCC proposes that Part 27 rules regulating antenna height and requiring the reduction of transmit power limit as the antenna height is increased be applied to the mmWave bands. In general, Starry believes that these rules are appropriate for these bands. For example, currently, Part 27 rules require for 1.5m height antenna, approximately a –94 dBm signal contour. We feel the relationship between antenna height and power level to be reasonable and do not object to antenna height limiting power for the mmWave band. However, Starry advocates for specific language to be added to Part 27 rules to account for the variations in technical characteristics between mmWave and low band spectrum.

Minimum Bandwidth for Given BS/MS/Transportable Transmit Power Levels

For next generation applications and technologies, Starry believes that the FCC should consider enabling a subset of networks to operate with bandwidths as small as 20 MHz. Given the frequency stability of commonly derived local oscillators, channel sizes of less than 20 MHz are not feasible.

Coordination Criteria at Market Borders for Fixed Point-to-Point Operations

Starry believes the existing coordination distances for traditional fixed point-to-point operations are no longer appropriate given the smaller market area sizes and should be reduced. Starry proposes that instead of solely using distance as a coordination criterion, a contour zone be established at 50 meters height above average ground level for traditional fixed point-to-point operations. Given the diversity of uses in these bands and the bands' unique technical characteristics, establishing a contour test for interference is more meaningful than absolute distance.

For example, interference from point-to-point operations may impact a point-to-multipoint operation more significantly in a certain geographic area over another. In order to enable diverse uses in these bands, we believe contours are a more sophisticated and comprehensive approach that takes into account the technological diversity that may exist in a band. Establishing a distance threshold is no longer sufficient to support a wide-variety of uses in a single band given that a variety of system types and usages are likely to exist.

Sharing Analysis and Modeling

From Starry's experience testing and deploying mmWave systems, we believe that remaining flexible as to which analytical model to base assumptions on is important due to the incredible variations in rain fade, foliage and geography that impact the propagation and performance in these bands. Propagation analysis and path loss models of mmWave deployments for outdoor environments vary greatly when taking into account rain fade, foliage (seasonality), construction materials and other geographic variables. A model that purports to explain the full impact of rain fade may be true for the Northwest United States, but if you moved that test to the Southeast United States, the data could be fundamentally different, and hence any model is by necessity very complex. Instead, Starry recommends the Commission continue to remain open-minded and flexible in developing its assumptions on the performance and interference issues posed by these bands, and maintain sharing and contour rules as discussed above.

Conclusion

The future of connectivity is wireless and access to spectrum is critical. We applaud the Commission's thoughtful approach and reiterate our support for strong competition and sharing rules that open the field to new entrants and encourage the development of new innovations that will power the next generation of wireless technologies.

Respectfully submitted on behalf of Starry, Inc.,

Virginia Lam Abrams
SVP, Communications & Government Relations
Starry, Inc.